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WHAT IS CLAIMED IS:

1. A network system including at least one cache server which comprises:

a quality-of-service (QoS) path information obtaining section for obtaining QoS path information

5 including network path information and path load information;

a path calculating section for obtaining a path suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a  
10 cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section; and

at least one of an automatic cache updating section, a link prefetching control section, and a cache  
15 server cooperating section, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation by using the path obtained by the path calculating section.

20 2. The network system according to claim 1, wherein the path calculating section obtains a maximum remaining bandwidth path as the path and a minimum remaining

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At least one of the automatic cache updating section, the link prefetching control section, and the cache server cooperating section determines whether a corresponding one of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation is carried out, based on the minimum remaining bandwidth.

a router on which a path control protocol operates to exchange network path information and path load information,

4. A network system comprising:

20           at least one cache server comprising:

a path calculating section for obtaining a path

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suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section; and

at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which request at least one of the path-settable routers to set the path obtained by the path calculating section and carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation, by using the path set by said at least one of the path-settable routers.

5. The network system according to claim 4, wherein the path calculating section obtains a maximum remaining bandwidth path as the path and a minimum remaining bandwidth on the path obtained, and the at least one of the automatic cache updating section, the link prefetching control section, and the cache server cooperating section determines whether a corresponding one of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation is carried out, based on the minimum remaining bandwidth.

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5           the QoS path information obtaining section  
obtains the network path information and the path load  
information in cooperation with at least one of the  
path-settable routers.

1. A network system comprising:

10 a plurality of routers;

at least one cache server; and

at least one relay server,

wherein each of the routers operates a path

control protocol to exchange network path information and

15 path load information,

the at least one cache server comprises:  
a quality of service (QoS) path information obtaining  
section for obtaining QoS path information including network  
path information and path load information in cooperation  
20 with at least one of the routers;

a relay control section for selecting at least one relay server suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based

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on the QoS path information obtained by the QoS path  
information obtaining section, and for instructing the  
selected at least one relay server about data to be relayed,  
and

5           the at least one relay server relays the data  
according to an instruction from the relay control section.

8.       The network system according to claim 7, wherein  
the relay control section selects the at least one relay  
server needed for setting a relay path on which there exists  
10   no congestion portion.

9.       The network system according to claim 8, wherein,  
when it is not possible to set a relay path on which there  
exists no congestion portion, the data is relayed to a relay  
server near to a congestion portion among relay servers that  
15   exist upstream from the congestion portion, wherein the  
relay server near to the congestion portion stores the data  
and, when the congestion has been disappeared, transfers the  
data to downstream.

10.      A network system comprising:  
20           a plurality of routers;  
          at least one cache server; and  
          at least one relay server,  
          wherein each of the routers operates a path

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control protocol to exchange network path information and path load information,

the at least one cache server comprises:

a quality-of-service (QoS) path information obtaining  
5 section for obtaining QoS path information including network path information and path load information in cooperation with at least one of the routers;

a relay control section for selecting at least one relay server and a path, which are suitable for carrying out  
10 at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section, and for instructing the selected at least one relay server about data to be  
15 relayed and to relay the data using the selected path, and

the at least one relay server relays the data according to an instruction from the relay control section.

11. A network system comprising:

a plurality of path-settable routers;  
20 at least one cache server; and  
at least one relay server,  
wherein each of the path-settable routers operates a path control protocol to exchange network path information and path load information and is allowed a  
25 requested path to be set on a network,

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said at least one cache server comprises:

a quality-of-service (QoS) path information obtaining section for obtaining QoS path information including network path information and path load information in cooperation  
5 with at least one of the routers;

a relay control section for selecting at least one relay server and a path, which are suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating  
10 operation, based on the QoS path information obtained by the QoS path information obtaining section, and for instructing the selected at least one relay server about data to be relayed;

a path setting section for requesting the selected at  
15 least one relay server to relay the data using the selected path, and

said at least one relay server relays the data according to an instruction from the relay control section.

12. The network system according to claim 11, wherein  
20 the relay control section selects the at least one relay server needed for setting a relay path on which there exists no congestion portion.

13. The network system according to claim 12, wherein, when it is not possible to set a relay path on which there

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exists no congestion portion, the data is relayed to a relay server near to a congestion portion among relay servers that exist upstream from the congestion portion, wherein the relay server near to the congestion portion stores the data and, when the congestion has been disappeared, transfers the data to downstream.

14. A network system comprising:

at least one priority controllable router capable of controlling a priority of transmitting a packet to a link, based on priority information added to the packet; and

at least one cache server for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, wherein a priority given to a packet to be used for communications generated by at least one of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation is lower than a priority given to a packet to be used for communications generated by a cache operation.

15. The network system according to claim 14, wherein

said at least one cache server comprises:

a priority providing section for providing a priority request source with a priority predetermined for



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each priority request source, when a request for providing a priority occurs;

a priority information adding section for adding priority information showing a priority to a packet, when  
5 the priority and the packet to be transmitted to the network have been received; and

a cache operating section, a link prefetching control section, an automatic cache updating section, and a cache server cooperating section, which request the  
10 priority providing section to provide a priority when a transmission packet has occurred, and pass the transmission packet and the priority provided by the priority providing section to the priority information adding section.

16. The network system according to claim 15, further  
15 comprising:

a QoS path information obtaining section for obtaining QoS path information including network path information and path load information,

wherein the priority providing section  
20 determines a priority based on a priority-request source and QoS path information obtained by the QoS path information obtaining section, when a request for providing a priority has occurred.

17. A network system having at least one priority

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controllable router and at least one cache server, wherein

said at least one priority controllable router provides priority information to a packet associated with a specific communication flow by identifying this

5 communication flow, and controls a priority of transmitting a packet to a link based on the priority information provided to the packet, and

said at least one cache server comprises:

a QoS path information obtaining section for obtaining  
10 QoS path information including network path information and path load information;

a priority providing section for obtaining a priority variable for each link of the network suitable for carrying out an automatic cache updating operation, a link  
15 prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section;

a router priority setting section for requesting the priority controllable router to set a priority to a specific  
20 communication flow, based on a result obtained by the priority providing section; and

at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the  
25 automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation by

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said at least one priority controllable router  
5 controls a priority of transmitting a packet to a link based  
on priority information provided to the packet, and

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        a QoS path information obtaining section for obtaining
        QoS path information that includes network path information
10    and path load information;

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at least one of an automatic cache updating section,  
a link prefetching control section, and a cache server  
cooperating section, which carry out respective ones of the  
25 automatic cache updating operation, the link prefetching

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operation, and the cache server cooperating operation, by using the path obtained by the path calculating section and using the packet of the priority provided by the path calculating section.

- 5           19. A network system having at least one priority controllable router and at least one cache server, wherein
- said at least one priority controllable router provides priority information to a packet associated with a specific communication flow by identifying this
- 10   communication flow, and controls a priority of transmitting a packet to a link based on the priority information provided to the packet, and
- said at least one cache server comprises:
- a QoS path information obtaining section for obtaining
- 15   QoS path information that includes network path information and path load information;
- a path calculating section for obtaining a path suitable for carrying out an automatic cache updating operation, a link prefetching operation, and a cache server
- 20   cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section, and for obtaining a priority variable for each link of the network suitable for carrying out the automatic cache updating operation, the link prefetching operation, and the cache
- 25   server cooperating operation;

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a router priority setting section for requesting the priority controllable router to set a priority to a specific communication flow, based on a result obtained by the path calculating section; and

5 at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation, by  
10 using a path obtained by the path calculating section.

20. A network system having at least one cache server and at least one router, wherein

said at least one router allowed to control a priority of transmitting a packet to a link, based on priority  
15 information provided to the packet, and to set a requested path on the network, and

said at least one cache server comprises:

a QoS path information obtaining section for obtaining QoS path information that includes network path information  
20 and path load information;

a path calculating section for obtaining a path suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path  
25 information obtained by the QoS path information obtaining

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section, and for providing priority information lower than  
priority information of a packet to be used for  
communications generated by a cache operation, to a packet  
to be used for communications generated by the automatic  
5 cache updating operation, the link prefetching operation,  
or the cache server cooperating operation;

a path setting section for requesting the router to  
set a path obtained by the path calculating section; and

at least one of an automatic cache updating section,  
10 a link prefetching control section, and a cache server  
cooperating section, which carry out respective ones of the  
automatic cache updating operation, the link prefetching  
operation, and the cache server cooperating operation, by  
using the packet of the priority provided by the path  
15 calculating section.

21. A network system having at least one cache server  
and at least one router, wherein

said at least one router provides priority  
information to a packet associated with a specific  
20 communication flow by identifying this communication flow,  
controls a priority of transmitting a packet to a link based  
on the priority information provided to the packet, and sets  
a requested path on the network, and

said at least one cache server comprises:

25 a QoS path information obtaining section for obtaining

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QoS path information that includes network path information and path load information;

5 a path calculating section for obtaining a path suitable for carrying out an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section, and for obtaining a priority variable for each link of the network suitable for carrying out the automatic cache updating  
10 operation, the link prefetching operation, and the cache server cooperating operation;

a router priority setting section for requesting a router to set a priority to a specific communication flow, based on a result obtained by the path calculating section;

15 a path setting section for requesting the router to set a path obtained by the path calculating section; and

at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the  
20 automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation, by using the path set by the router.

22. A network system having at least one cache server, at least one relay server, and at least one router, wherein  
25 said at least one router controls a priority of

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transmitting a packet to a link, based on priority information provided to the packet,

said at least one cache server comprises:

a QoS path information obtaining section for obtaining

5 QoS path information that includes network path information and path load information;

a relay control section for selecting a relay server suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a  
10 cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section, instructing the selected relay server about data to be relayed, and providing priority information lower than priority information of a packet to be used for  
15 communications generated by a cache operation, to a packet to be used for communications generated by the automatic cache updating operation, the link prefetching operation, or the cache server cooperating operation; and

at least one of an automatic cache updating section,  
20 a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation, by using the packet of the priority provided by the relay control  
25 section, and

the relay server relays the data according to an



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instruction received from the relay control section.

23. A network system having at least one cache server,  
at least one relay server, and at least one router, wherein  
said at least one router provides priority

5 information to a packet associated with a specific  
communication flow by identifying this communication flow,  
and controls a priority of transmitting a packet to a link  
based on the priority information provided to the packet,

said at least one cache server comprises:

10 a QoS path information obtaining section for obtaining  
QoS path information that includes network path information  
and path load information;

a relay control section for selecting a relay server  
suitable for carrying out at least one of an automatic cache  
15 updating operation, a link prefetching operation, and a  
cache server cooperating operation, based on the QoS path  
information obtained by the QoS path information obtaining  
section, instructing the selected relay server about data  
to be relayed, and obtaining a priority variable for each  
20 link of the network suitable for carrying out an automatic  
cache updating operation, a link prefetching operation, or  
a cache server cooperating operation;

a router priority setting section for requesting a  
router to set a priority of a specific communication flow,  
25 based on a result obtained by the relay control section; and

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at least one of an automatic cache updating section,  
a link prefetching control section, and a cache server  
cooperating section, which carry out respective ones of the  
automatic cache updating operation, the link prefetching  
5 operation, and the cache server cooperating operation  
respectively, by using the packet of the priority provided  
by the relay control section, and

said at least one relay server relays the data  
according to an instruction received from the relay control  
10 section.

24. A network system having at least one cache server,  
at least one relay server, and at least one router, wherein  
said at least one router controls a priority of  
transmitting a packet to a link, based on priority  
15 information provided to the packet,

said at least one cache server comprises:

a QoS path information obtaining section for obtaining  
QoS path information that includes network path information  
and path load information;  
20 a relay control section for selecting a path and a relay  
server, which are suitable for carrying out at least one of  
an automatic cache updating operation, a link prefetching  
operation, and a cache server cooperating operation, based  
on the QoS path information obtained by the QoS path  
25 information obtaining section, instructing the selected

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relay server about data to be relayed and instructing the selected relay server to relay the data using the selected path, and providing priority information lower than priority information of a packet to be used for communications

5 generated by a cache operation, to a packet to be used for communications generated by the automatic cache updating operation, the link prefetching operation, or the cache server cooperating operation; and

at least one of an automatic cache updating section,  
10 a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation respectively, by using the packet of the priority provided  
15 by the relay control section, and

said at least one relay server relays the data according to an instruction received from the relay control section.

25. A network system having at least one cache server,  
20 at least one relay server, and at least one router, wherein  
said at least one router provides priority information to a packet associated with a specific communication flow by identifying this communication flow, and controls a priority of transmitting a packet to a link  
25 based on the priority information provided to the packet,

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said at least one cache server comprises:

a QoS path information obtaining section for obtaining QoS path information that includes network path information and path load information;

5 a relay control section for selecting a path and a relay server suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining  
10 section, instructing the selected relay server about data to be relayed, instructing the selected relay server to relay the data using the selected path, and obtaining a priority variable for each link of the network suitable for carrying out an automatic cache updating operation, a link  
15 prefetching operation, or a cache server cooperating operation;

a router priority setting section for requesting the router to set a priority of a specific communication flow, based on a result obtained by the relay control section; and

20 at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation  
25 respectively, by using the packet of the priority provided by the relay control section, and

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said at least one relay server relays the data according to an instruction received from the relay control section.

26. A network system having at least one cache server,  
5 at least one relay server, and at least one router, wherein

said at least one router controls a priority of transmitting a packet to a link, based on priority information provided to the packet, and sets a requested path on the network,

10 said at least one cache server comprises:

a QoS path information obtaining section for obtaining QoS path information that includes network path information and path load information;

a relay control section for selecting a path and a relay  
15 server suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section, instructing the selected relay server about data  
20 to be relayed, and providing priority information lower than priority information of a packet to be used for communications generated by a cache operation, to a packet to be used for communications generated by the automatic cache updating operation, the link prefetching operation,  
25 or the cache server cooperating operation;

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a path setting section for requesting a router to set the path obtained by the relay control section; and

at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation respectively, by using the packet of the priority provided by the relay control section, and

said at least one relay server relays the data according to an instruction received from the relay control section.

27. A network system having at least one cache server, at least one relay server, and at least one router, wherein

said at least one router provides priority information to a packet relating to a specific communication flow by identifying this communication flow, controls a priority of transmitting a packet to a link based on the priority information provided to the packet, and sets a requested path on the network,

said at least one cache server comprises:

a QoS path information obtaining section for obtaining QoS path information that includes network path information and path load information;

a relay control section for selecting a path and a relay

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server suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section, instructing the selected relay server about data to be relayed, and obtaining a priority variable for each link of the network suitable for carrying out an automatic cache updating operation, a link prefetching operation, or a cache server cooperating operation;

10 a router priority setting section for requesting the router to set a priority of a specific communication flow, based on a result obtained by the relay control section;

a path setting section for requesting the router to set the path obtained by the relay control section; and

15 at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation

20 respectively, by using the packet of the priority provided by the relay control section, and

said at least one relay server relays the data according to an instruction of the relay control section.

28. A cache server comprising:

25 a QoS path information obtaining section for

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obtaining QoS path information that includes network path information and path load information;

a path calculating section for obtaining a path suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section; and

at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation respectively, by utilizing the path obtained by the path calculating section.

29. A cache server comprising:

a QoS path information obtaining section for obtaining QoS path information that includes network path information and path load information, in cooperation with at least one path-suitable router that operates a path control protocol to exchange network path information and path load information and sets a requested path on the network;

a path calculating section for obtaining a path suitable for carrying out at least one of an automatic cache



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updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section; and

5                   at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section that requests the path-settable router to set the path obtained by the path calculating section, and carry out respective ones of the automatic cache  
10                   updating operation, the link prefetching operation, and the cache server cooperating operation respectively, by utilizing the path set by the path-settable router.

30.   A cache server comprising:

                  a QoS path information obtaining section for  
15                   obtaining QoS path information that includes network path information and path load information, in cooperation with at least one router that operates a path control protocol to exchange network path information and path load  
                  information; and

20                   a relay control section for selecting a relay server suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining  
25                   section, and instructing the selected relay server about

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Figure 1. The effect of the concentration of the *Agrobacterium* suspension on the transformation efficiency of *Agrobacterium* strains. The cells were grown in YEA medium at 28°C for 24 h. The cell concentration was adjusted to 10<sup>8</sup> cells/ml. The cells were then mixed with the plant tissue and incubated for 24 h. The plant tissue was then cultured on the selective medium. The transformation efficiency was calculated as the number of transformants per 10<sup>8</sup> cells. The data are the mean ± SD of three independent experiments.

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the cache server carries out at least one of an

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automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, and provides priority information to a packet to be used for communications generated by the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation.

33. The cache server according to Claim 32, further comprising:

a priority providing section for providing a priority request source with a priority predetermined for each request source, when there has been a request for providing a priority;

a priority information adding section for adding priority information showing the priority to a packet, when the packet to be transmitted to the network and the priority have been received; and

a cache operating section, a link prefetching control section, an automatic cache updating section, and a cache server cooperating section, each of which requests the priority providing section to provide a priority when a transmission packet has been generated, and passes the priority provided by the priority providing section and the transmission packet to the priority information adding section.

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34. A cache server on a network provided with at least one priority controllable router that provides priority information to a packet associated with a specific communication flow by identifying this communication flow, and controls a priority of transmitting a packet to a link based on the priority information provided to the packet, the cache server comprising:

a QoS path information obtaining section for obtaining QoS path information that includes network path information and path load information;

a priority providing section for obtaining a priority variable for each link of the network suitable for carrying out an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section;

a router priority setting section for requesting at least one priority controllable router to set a priority to a specific communication flow, based on a result obtained by the priority providing section; and

at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation respectively, by utilizing a path set by the

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priority controllable router.

35. A relay server for relaying data necessary for at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, according to an instruction received from a relay control section provided in a cache server.

36. The relay server according to claim 35, wherein the relay server relays data for each content.

37. A router provided on a network, comprising:  
a QoS path information obtaining section for obtaining QoS path information that includes network path information and path load information; and  
a relay control section for selecting a router having a relay function suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section, and for notifying the selected router of data to be relayed,  
wherein the QoS path information obtaining section and the relay control section are provided within a housing of the router, wherein the router relays the data according to an instruction received from a relay control

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section within another router.

38. A router provided on a network, allowing a requested path to be set on the network, the router comprising:

5 a QoS path information obtaining section for obtaining QoS path information that includes network path information and path load information;

10 a relay control section for selecting a path and a router having a relay function suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section, and for notifying a selected relay server of data to be relayed; and

15 a path setting section for requesting the router to set the path selected by the relay control section,

20 wherein the QoS path information obtaining section, the relay control section and the path setting section are provided within a housing of the router, wherein the router relays the data according to an instruction received from a relay control section within another router.

39. A cache server controlling method comprising the steps of:

a) obtaining QoS path information that includes

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network path information and path load information;

b) obtaining a path suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained at the step (a); and

c) providing at least one of an automatic cache updating step, a link prefetching control step, and a cache server cooperating step, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation, by utilizing the path obtained at the step (b).

40. A cache server controlling method comprising the steps of:

a) obtaining QoS path information that includes network path information and path load information, in cooperation with at least one path-settable router that operates a path control protocol to exchange network path information and path load information and sets a requested path on the network;

b) obtaining a path suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained at the step (a);

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c) requesting at least one path-settable router to set the path obtained by the step (b); and

d) providing at least one of an automatic cache updating step, a link prefetching control step, and a cache server cooperating step, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation, by utilizing the path set by said at least one path-settable router.

10 41. A cache server controlling method comprising the steps of:

a) obtaining QoS path information that includes network path information and path load information, in cooperation with at least one router that operates a path control protocol to exchange network path information and path load information;

b) selecting at least one relay server suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained at the step (a); and

c) instructing said at least one selected relay server about data to be relayed.

42. A cache server controlling method comprising the



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steps of:

a) obtaining QoS path information that includes network path information and path load information, in cooperation with at least one path-settable router that  
5 operates a path control protocol to exchange network path information and path load information and sets a requested path on the network;

b) selecting at least one relay server and a path, which are suitable for carrying out at least one of an  
10 automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained at the QoS path information obtaining step, and instructing said at least one selected relay server about data to be relayed; and

15 c) requesting said at least one path settable router to set the path selected at the step (b).

43. A method for controlling a cache server provided on a network system having at least one priority controllable router capable of controlling a priority of transmitting a  
20 packet to a link based on priority information provided to the packet, the method comprising the steps of:

a) carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation; and

25 b) providing priority information to a packet to

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be used for communications generated by the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation.

44. A method for controlling a cache server provided  
5 on a network system including at least one priority  
controllable router which provides priority information to  
a packet associated with a specific communication flow by  
identifying this communication flow and controls a priority  
10 of transmitting a packet to a link based on the priority  
information provided to the packet, the method comprising  
the steps of:
- a) obtaining QoS path information that includes  
network path information and path load information;
  - b) obtaining a priority variable for each link  
15 of the network suitable for carrying out an automatic cache  
updating operation, a link prefetching operation, and a  
cache server cooperating operation, based on the QoS path  
information obtained at the step (a);
  - c) requesting at least one priority controllable  
20 router to set a priority, based on a result obtained at the  
step (b); and
  - d) providing at least one of an automatic cache  
updating step, a link prefetching control step, and a cache  
server cooperating step, which carry out respective ones of  
25 the automatic cache updating operation, the link prefetching

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operation, and the cache server cooperating operation, by utilizing a path set by the priority controllable router.

45. A recording medium storing a program for instructing a computer to function as:

5 a quality-of-service (QoS) path information obtaining section for obtaining QoS path information including network path information and path load information;

10 a path calculating section for obtaining a path suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section; and

15 at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating  
20 operation by using the path obtained by the path calculating section.

46. A recording medium storing a program for instructing a computer to function as:

a QoS path information obtaining section for

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obtaining QoS path information that includes network path information and path load information, in cooperation with at least one path-settable router that operates a path control protocol to exchange network path information and path load information and sets a requested path on the network;

a path calculating section for obtaining a path suitable for carrying out at least one of an automatic cache updating operation, a link prefetching operation, and a cache server cooperating operation, based on the QoS path information obtained by the QoS path information obtaining section; and

at least one of an automatic cache updating section, a link prefetching control section, and a cache server cooperating section, which request the path settable router to set the path obtained by the path calculating section, and carry out respective ones of the automatic cache updating operation, the link prefetching operation, and the cache server cooperating operation, by utilizing the path set by the path-settable router.

47. A recording medium storing a program for use in a computer of a cache server provided on a network system having at least one priority controllable router that controls a priority of transmitting a packet to a link based on priority information provided to the packet, the program

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instructing the computer to function as:

- a priority providing section for providing a priority request source with a priority predetermined for each request source, when there has been a request for providing a priority;

a priority information adding section for adding priority information showing a priority to a packet, when the packet to be transmitted to the network and the priority have been received; and

- 10 a cache operating section, a link prefetching control section, an automatic cache updating section, and a cache server cooperating section, which request the priority providing section to provide a priority when a transmission packet has been generated, and pass the
- 15 priority provided by the priority providing section and the transmission packet to the priority information adding section.

48. A recording medium storing a program for instructing a computer to function as:

- 20 a QoS path information obtaining section for obtaining QoS path information that includes network path information and path load information, in cooperation with at least one router that operates a path control protocol to exchange network path information and path load
- 25 information; and

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control section.

50. The network system according to claim 22, wherein the relay control section selects at least one relay server that is necessary for setting a relay path on which there  
5 exists no congestion portion.

51. The network system according to claim 50, wherein when it is not possible to set a relay path on which there exists no congestion portion, the data is relayed to a relay server near to a congestion portion among relay servers that  
10 exist upstream from the congestion portion, wherein the data is stored and, when the congestion has disappeared, the data is transferred to downstream from the congestion portion.

52. The network system according to claim 23, wherein the relay control section selects at least one relay server  
15 that is necessary for setting a relay path on which there exists no congestion portion.

53. The network system according to claim 52, wherein when it is not possible to set a relay path on which there exists no congestion portion, the data is relayed to a relay  
20 server near to a congestion portion among relay servers that exist upstream from the congestion portion, wherein the data is stored and, when the congestion has disappeared, the data

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is transferred to downstream from the congestion portion.

54. The network system according to claim 24, wherein the relay control section selects at least one relay server that is necessary for setting a relay path on which there  
5 exists no congestion portion.

55. The network system according to claim 54, wherein when it is not possible to set a relay path on which there exists no congestion portion, the data is relayed to a relay server near to a congestion portion among relay servers that  
10 exist upstream from the congestion portion, wherein the data is stored and, when the congestion has disappeared, the data is transferred to downstream from the congestion portion.

56. The network system according to claim 25, wherein the relay control section selects at least one relay server  
15 that is necessary for setting a relay path on which there exists no congestion portion.

57. The network system according to claim 56, wherein when it is not possible to set a relay path on which there exists no congestion portion, the data is relayed to a relay  
20 server near to a congestion portion among relay servers that exist upstream from the congestion portion, wherein the data is stored and, when the congestion has disappeared, the data



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is transferred to downstream from the congestion portion.

58. The network system according to claim 26, wherein the relay control section selects at least one relay server that is necessary for setting a relay path on which there  
5 exists no congestion portion.

59. The network system according to claim 58, wherein when it is not possible to set a relay path on which there exists no congestion portion, the data is relayed to a relay server near to a congestion portion among relay servers that  
10 exist upstream from the congestion portion, wherein the data is stored and, when the congestion has disappeared, the data is transferred to downstream from the congestion portion.

60. The network system according to claim 27, wherein the relay control section selects at least one relay server  
15 that is necessary for setting a relay path on which there exists no congestion portion.

61. The network system according to claim 60, wherein when it is not possible to set a relay path on which there exists no congestion portion, the data is relayed to a relay  
20 server near to a congestion portion among relay servers that exist upstream from the congestion portion, wherein the data is stored and, when the congestion has disappeared, the data

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62. A network system including a plurality of routers and at least one cache server, said at least one cache server comprising:

a path calculator for calculating a path for use  
in a cache control operation that is at least one of an  
10 automatic cache updating operation, a link prefetching  
operation, and a cache server cooperating operation; and

15           63.    The network system according to claim 62, wherein  
the controller comprises:

20           64.    The network system according to claim 62, wherein  
said at least one cache server further comprises:

a priority controller for providing a first priority to a packet for use in a communication associated

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with the cache control operation, wherein the first priority is lower than a second priority provided to a communication associated with an ordinary operation of said at least one cache server.